

## PRINCIPLES OF MANUFACTURING

### COURSE DESCRIPTION

*Principles of Manufacturing* focuses on the essential principles that must be mastered for a person to be effective in manufacturing production work. The course is intended for students more interested in production than engineering. The course covers customers, quality principles and processes, systems, information in the workplace, the business of manufacturing, and statistical process control.

The course is contextual by design. It connects what is being learned to the learner's current experience, past knowledge, and future conduct. Wherever possible, real-world or simulation hands-on experiences become the context in which instruction is delivered.

<b>Prerequisite(s):</b>	<b>None</b>
<b>Recommended Credits:</b>	<b>1</b>
<b>Recommended Grade Level(s):</b>	<b>10<sup>th</sup> or 11th</b>

<b>PRINCIPLES OF MANUFACTURING STANDARDS</b>
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- 1.0 Students will analyze the components of a manufacturing system.
- 2.0 Students will adapt processes to meet customer needs using quality principles.
- 3.0 Students will access, test, record, organize and evaluate information typical of a manufacturing workplace.
- 4.0 Students will analyze the fundamental organizational components of manufacturing organizations.
- 5.0 Students will analyze the fundamental economic components and functions of manufacturing organizations.
- 6.0 Students will implement quality and statistical process control procedures to ensure and improve quality in manufacturing processes.
- 7.0 Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

## **PRINCIPLES OF MANUFACTURING**

### **STANDARD 1.0**

Students will analyze the components of manufacturing systems.

### **LEARNING EXPECTATIONS**

The student will:

- 1.1 Analyze the systems common to manufacturing organizations.
- 1.2 Evaluate the role of customers in the manufacturing process.

### **PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET**

The student:

- 1.1.A Diagrams an end-to-end manufacturing workflow that brings revenue to an organization and the dependencies in the system.
- 1.1.B Categorizes a manufacturing system as customized, batch, or continuous.
- 1.1.C Distinguishes between natural, synthetic, and mixed materials.
- 1.1.D Correlates the interchangeability of parts with increased effectiveness in manufacturing processes.
- 1.1.E Illustrates the interrelationships between a worker and the worker's team.
- 1.2.A Analyzes the meaning and function of a "customer".
- 1.2.B Compares and contrasts internal and external customers and their relationships to the manufacturing process.
- 1.2.C Assesses customer needs and correlates them to the manufacturing process.
- 1.2.D Differentiates between durable and non-durable goods.

### **SAMPLE PERFORMANCE TASKS**

- Students apply concepts in the context of a manufacturing simulation in which a product moves through the various work processes.
- Students conduct customer and supplier interviews.
- Students flowchart a system process.

### **INTEGRATION/LINKAGES**

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995.

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology*. International Technology Education Association. Reston, VA, 2000.

Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001.

Ford Academy of Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum.

Mathematics/Quality/Teamwork content.

## **PRINCIPLES OF MANUFACTURING**

### **STANDARD 2.0**

Students will adapt processes to meet customer needs using quality principles.

### **LEARNING EXPECTATIONS**

The student will:

- 2.1 Assess the effects of quality assurance on manufacturing processes.
- 2.2 Analyze the relationship between process management and quality assurance.

### **PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET**

The student:

- 2.1.A Infers the relationship between quality and customers.
- 2.1.B Diagrams a quality process.
- 2.1.C Illustrates key principles and concepts of quality assurance.
- 2.1.D Concludes the benefits of implementing quality assurance.
- 2.1.E Correlates quality with the critical success factors of an organization.
- 2.2.A Incorporates principles of process management.
- 2.2.B Assesses advantages of process management.
- 2.2.C Validates the need for feedback loops within a system.
- 2.2.D Devises modifications to a manufacturing process.

### **SAMPLE PERFORMANCE TASKS**

- Students apply concepts in the context of a manufacturing simulation in which a product moves through the various work processes.
- Students conduct customer and supplier interviews.
- Students use quality-improvement tools such as Plan-Do-Check-Act or seven-step problem-solving model.
- Students flowchart a system process.

### **INTEGRATION/LINKAGES**

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995.

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology*. International Technology Education Association. Reston, VA, 2000.

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Mathematics/Quality/Teamwork content.

## **PRINCIPLES OF MANUFACTURING**

### **STANDARD 3.0**

Students will access, test, record, organize and evaluate information typical of a manufacturing workplace.

### **LEARNING EXPECTATIONS**

The student will:

- 3.1 Access and process data commonly used in manufacturing.
- 3.2 Test data relevant to manufacturing processes.
- 3.3 Record data relevant to manufacturing processes.
- 3.4 Organize data relevant to manufacturing processes.
- 3.5 Evaluate data relevant to manufacturing processes.

### **PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET**

The student:

- 3.1.A Locates and collects reliable and relevant data from pertinent sources.
- 3.1.B Processes data according to requirements of a given manufacturing situation.
- 3.2.A Reports any deviation from expected results.
- 3.2.B Makes modifications based on facts to improve the process.
- 3.3.A Judges the relevance of data to a given process.
- 3.3.B Maintains accurate logs of information.
- 3.4.A Incorporates statistical processes to analyze data.
- 3.4.B Interprets findings using process-control data.
- 3.4.C Uses diagrams and drawings to convey information.
- 3.5.A Selects an appropriate set of criteria for evaluating data.
- 3.5.B Evaluates information according to a set of criteria.

### **SAMPLE PERFORMANCE TASKS**

- Students use information effectively in the context of a simulation in which a product is “manufactured.”
- Anticipatory activity—scavenger hunt for information
- Students make measurements.
- Students flowchart a process.
- Students role-play benefits of information sharing.
- Students forecast information.
- Students record information on spreadsheets.
- Students sort and graph data electronically.
- Students critique presentations.

## INTEGRATION/LINKAGES

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995.

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology*. International Technology Education Association. Reston, VA, 2000.

Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Ford Academy of Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum.

Mathematics/Reading/Communications content.

## **PRINCIPLES OF MANUFACTURING**

### **STANDARD 4.0**

Students will analyze the fundamental organizational components of manufacturing organizations.

### **LEARNING EXPECTATIONS**

The student will:

- 4.1 Analyze organizational designs and structures.
- 4.2 Analyze organizational systems and processes.
- 4.3 Assess the role of personal accountability within an organization.

### **PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET**

The student:

- 4.1.A Distinguishes various organizational designs and assesses the impact of each on people and work.
- 4.1.B Differentiates between formal and informal organizations and illustrates their relationships to one another.
- 4.2.A Categorizes the various bases of power and leadership.
- 4.2.B Shows the dynamic relationship among organizational units.
- 4.2.C Illustrates the communication system used in organizational designs.
- 4.2.D Predicts the impact of quality initiatives on the success of an organization.
- 4.2.E Demonstrates the importance of feedback loops.
- 4.3.A Assesses the impact of an individual's behavior on an organizational system.
- 4.3.B Demonstrates personal accountability.

### **SAMPLE PERFORMANCE TASKS**

- Students identify the parts of an organization, such as the school.
- Students identify the climate and culture of the organization.
- Students identify their personality traits and types.
- Students identify management styles of leaders known to the students.
- Students complete circle activity to demonstrate being a component in a system.
- Students play a board game that demonstrates how change in one part of an organization impacts other parts of the organization.
- Students participate in relay game to highlight personal accountability.
- Students draw reinforcing feedback loops to highlight individual accountability.

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International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology*. International Technology Education Association. Reston, VA, 2000. Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Ford Academy of Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum. Economics/Business content.



## **PRINCIPLES OF MANUFACTURING**

### **STANDARD 5.0**

Students will analyze the fundamental economic components and functions of manufacturing organizations.

### **LEARNING EXPECTATIONS**

The student will:

- 5.1 Analyze the basic economic principles that impact manufacturing operations.
- 5.2 Draw conclusions and make inferences from company financial statements.
- 5.3 Contrast the costs of preventive maintenance and safety practices with the costs of equipment repair and workplace accidents.

### **PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET**

The student:

- 5.1.A Investigates the need for profitability of a manufacturing business.
- 5.1.B Determines factors that lead to profit and loss.
- 5.1.C Judges whether or not a product feature is value-added.
- 5.1.D Categorizes marketing activity as product identity, research, distribution, or sales.
- 5.2.A Interprets data contained in a financial report.
- 5.2.B Assesses factors that affect variability of costs and steps in the manufacturing process that impact cost.
- 5.2.C Calculates the cost of employee benefits and analyzes the role of organized labor in determining salary and benefits.
- 5.3.A Compares the costs of accident prevention with the costs of accidents.
- 5.3.B Compares the cost of servicing to keep in good repair versus replacing or repairing.

### **SAMPLE PERFORMANCE TASKS**

- Students analyze company financial statements.
- Students participate in manufacturing scenarios/simulations that require them to make decisions and then examine the economic consequences of those decisions.

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Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing)*. Manufacturing Skill Standards Council, 2001. Ford Academy of

Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum. Mathematics content.

## **PRINCIPLES OF MANUFACTURING**

### **STANDARD 6.0**

Students will implement quality and statistical process control procedures to ensure and improve quality in manufacturing processes.

### **LEARNING EXPECTATIONS**

The student will:

- 6.1 Analyze the contributing factors to an industrial process.
- 6.2 Use statistical process control concepts to evaluate and modify manufacturing processes.

### **PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET**

The student:

- 6.1.A Predicts the effect of workplace documentation on specific work.
- 6.1.B Determines the problem in a manufacturing process.
- 6.1.C Resolves the problem by applying appropriate problem-solving techniques.
- 6.2.A Performs basic mathematical calculations, calibrations, and measurements.
- 6.2.B Conducts an in-process inspection and uses the information to adjust a process.
- 6.2.C Performs a Pareto Chart analysis.
- 6.2.D Traces the source of any large disparity using the following tools and concepts:
  - control charts
  - histograms and specifications
  - variability and predictability
  - shape of a distribution, measures of center, measures of spread
  - interpreting a curve and plotting the X-bar and R control chart
  - special cause variation

### **SAMPLE PERFORMANCE TASKS**

- Students determine an acceptable range of ripeness for fruit they might purchase.
- Students complete a Pareto Chart.
- Students construct a histogram.
- Students construct a fishbone diagram.
- Students participate in a Law of Large Numbers activity.
- Students calculate center and spread.
- Students plot a control chart.
- Students interpret a control chart.

### **INTEGRATION/LINKAGES**

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995.

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology*. International Technology Education Association. Reston, VA, 2000. Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Ford Academy of Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum. Mathematics content.

## **STANDARD 7.0**

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

### **LEARNING EXPECTATIONS**

The student will:

- 7.1 Exhibit positive leadership skills.
- 7.2 Participate in SkillsUSA-VICA as an integral part of classroom instruction.
- 7.3 Assess situations and apply problem-solving and decision-making skills to particular client relations in the community, and workplace.
- 7.4 Demonstrate the ability to work cooperatively with others in a professional setting.

### **PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET**

The student:

- 7.1 Demonstrates character, leadership, and integrity using creative and critical-thinking.
- 7.2.A Applies the points of the creed to personal and professional situations.
- 7.2.B Participates and conducts meetings and other business according to accepted rules of parliamentary procedure.
- 7.3.A Analyzes situations in the workplace and uses problem-solving techniques to solve the problem.
- 7.4.A Participates in a community service project.
- 7.4.B Assists with an officer campaign with Tennessee SkillsUSA-VICA.

### **SAMPLE PERFORMANCE TASKS**

- Create a leadership inventory and use it to conduct a personal assessment.
- Participate in various SkillsUSA-VICA programs and/or competitive events.
- Evaluate an activity within the school, community, and/or workplace and project effects of the project.
- Implement an annual program of work.
- Prepare a meeting agenda for a SkillsUSA-VICA monthly meeting.
- Attend a professional organization meeting.
- Participate in the American Spirit Award competition with SkillsUSA-VICA.

### **INTEGRATION LINKAGES**

SkillsUSA-VICA, *Professional Development Program*, SkillsUSA-VICA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Math, Math for Technology, Applied Communications, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies



## **PRINCIPLES OF MANUFACTURING**

### **SAMPLING OF AVAILABLE RESOURCES**

CORD. *Necessary Skills Now for Manufacturing*. Waco, TX: CORD Communications, 1999.

Quirk, Michael. *Manufacturing, Teams and Improvement: The Human Art of Manufacturing*. Prentice Hall, 1998.

Wright, R. Thomas. *Exploring Manufacturing*. Tinley Park, IL: Goodheart-Willcox, 1993..

Quirk, Michael. *Manufacturing, Teams and Improvement: The Human Art of Manufacturing*. Prentice Hall, 1998.

Groover, Mikell P. *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*. John Wiley and Sons, 2001.

Amrine, Harold. Ritchey, John. Moodie, Colin. Kmec, Joseph. *Manufacturing Organization and Management*. Prentice Hall, 1992.

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995.

Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001.